

Ramy Osman - ST04 , PK2  
305-8050 • 2157

US006545977B2

(12) United States Patent  
Harshavardhana et al.

(10) Patent No.: US 6,545,977 B2  
(45) Date of Patent: \*Apr. 8, 2003

(54) METHODS AND APPARATUS FOR ROUTING SIGNALS IN A RING NETWORK

(75) Inventors: Paramaslviah Harshavardhana, Marlboro, NJ (US); Srinivasan S. Ravikumar, Morristown, NJ (US); Yufei Wang, Holmdel, NJ (US)

(73) Assignee: Lucent Technologies Inc., Murray Hill, NJ (US)

(\*) Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 09/090,083

(22) Filed: Jun. 3, 1998

(65) Prior Publication Data

US 2001/0012298 A1 Aug. 9, 2001

(51) Int. Cl. .... G01R 31/08

(52) U.S. Cl. .... 370/222; 370/404

(58) Field of Search .... 370/222, 223, 370/224, 238, 254, 258, 400, 351, 452, 401, 402, 403, 404, 405

(56) References Cited

U.S. PATENT DOCUMENTS

- |             |                                 |         |
|-------------|---------------------------------|---------|
| 5,299,207 A | • 3/1994 Fujii .....            | 714/4S  |
| 5,394,389 A | • 2/1995 Kremec .....           | 370/223 |
| 5,406,549 A | • 4/1995 Kreher .....           | 370/224 |
| 5,546,542 A | • 8/1996 Cossares et al. ....   | 709/241 |
| 5,742,774 A | • 4/1998 Al-Salameh et al. .... | 709/251 |
| 5,815,489 A | • 9/1998 Takatori et al. ....   | 370/217 |
| 6,021,113 A | • 2/2000 Doshi et al. ....      | 370/228 |
| 6,034,758 A | • 3/2000 Oberg .....            | 359/119 |
| 6,073,248 A | • 6/2000 Doshi et al. ....      | 714/4   |
| 6,111,941 A | • 8/2000 Schreyer .....         | 379/207 |

# 474548

OTHER PUBLICATIONS

B. Doshi et al., "Dual Ring Interworking: High Penalty Cases and How to Avoid Them," Proceedings of ITC 15, Jun. 1997.

[REDACTED] M. Buyukkoc, "Load Balancing on SONET Rings," Proceedings of ITC '96, Istanbul, pp. 763-766, 1996.

[REDACTED] S. Sajeev, "An Optimization Problem Related to Bandwidth Loading on SONET Rings," Telecommunication Systems, vol. 5, pp. 165-181, 1994.

B. Doshi et al., "Overview of INDIT—A New Tool for Next Generation Network Design," Proceedings of IEEE Globecom, Nov. 1995.

\* cited by examiner

Primary Examiner—Wellington Chin

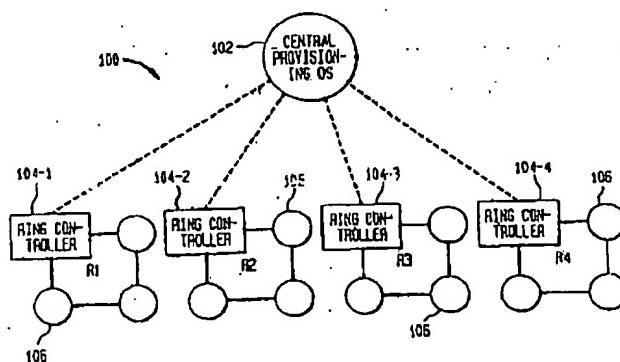
Assistant Examiner—Brenda Pham

(74) Attorney, Agent, or Firm—Ryan, Mason & Lewis, LLP

(57) ABSTRACT

Traffic demands are routed in a ring network by first determining an inter-ring path for a given demand, and then independently determining an intra-ring path for the demand on each of the rings in the inter-ring path. The intra-ring path provisioning is fully decoupled from the inter-ring path provisioning, such that the demand can be routed more quickly and efficiently. For example, both the routing direction and the interworking nodes for a dual ring interworking (DRI) connection can be determined independently for each of the rings of the inter-ring path. The invention may be implemented in the form of a hybrid centralized/distributed network architecture, in which a central operations system or other central controller determines the inter-ring path by applying a shortest path algorithm to a ring graph in which nodes represent rings in the network and links represent ring interconnections in the network. Ring controllers in the rings of the inter-ring path then each independently determine an intra-ring path for their corresponding rings. Although particularly well suited for use with DRI, the invention can also improve routing performance in single ring interworking (SRI) applications, as well as applications involving combinations of DRI and SRI.

18 Claims, 6 Drawing Sheets



12/03/2003, EAST Version: 1.4.1

12/04/03 15:11 87033065509  
USPTO EIC  
STIC EIC  
12/10/03 17:19 FAX 703 305 2763  
12/02/004  
12/002

**U.S. DEPARTMENT OF COMMERCE**  
**Patent and Trademark Office**

## **DOCUMENT RETRIEVAL REQUEST FORM**

Requester's Name: Ramy Osman		Case Serial Number:	Art Unit/Org.: 2157
Phone: 305-8050	RightFax: 746 6292	Building: PK2	Room Number:
Date of Request: 12/04/03		Date Needed By	
Paste or add text of citation or bibliography:		Paste Citation	Only one request per form. Original copy only.
Author/Editor:	See Attached		
Journal Title:			
Article Title:			
Volume Number:	Report Number:	Pages:	
Issue Number:	Series Number:	Year of Publication:	
Publisher:			
Remarks:	No Citation Available		
(41)	474548		